a considerable amount of blue rays. M. Teisserenc de Bort explained the existence of a vertical barometric gradient, first noticed in mountain observations, but lately measured more exactly on the Eiffel Tower.—The zodiacal light as related to terrestrial temperature observations, by O. T. Sherman.—Features of Hawaiian climate, by C. L. Lyons, in charge of the Weather Service there. The temperature averages for January are 69° to 71°, and in July and August 78° and 79°. The daily range is greater than is generally supposed, averaging 11° for the year, and some days over 20°. The maximum temperature is 89°, and the minimum 55°.—High-level meteorological observatories in France, by A. L. Rotch; and other articles of minor importance.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 17.—"The 'Ginger-beer Plant, and the Organisms composing it: a Contribution to the Study of Fermentation-yeasts and Bacteria." By H. Marshall Ward, Sc.D., F.R.S., F.L.S., Professor of Botany at the Forest School, Royal Indian Engineering College, Cooper's Hill.

The author has been engaged for some time in the investigation of a remarkable compound organism known to villagers as the "ginger-beer plant."

It occurs as jelly-like, semi-transparent, yellowish-white masses, aggregated into brain-like clumps, or forming deposits at the bottom of the fermentations, and presents resemblances to the so-called *Kephir* grains of the Caucasus, with which, however, it is by no means identical.

He finds that it consists essentially of a symbiotic association of a specific *Saccharomycete* and a *Schizomycete*, but, as met with naturally, invariably has other species of yeasts, bacteria, and mould-fungi casually associated with these.

He has successfully undertaken the separation of the various forms, and groups them as follows:—

(1) The essential organisms are a yeast, which turns out to be a new species allied to *Saccharomyces ellipsoideus* (Reess and Hansen), and which he proposes to call *S pyriformis;* and a bacterium, also new and of a new type, and named by him *Bacterium vermiforme.*

(2) Two other forms were met with in all the specimens (from various parts of the country and from America) examined—*Mycoderma cerevisiæ* (Desm.) and *Bacterium aceti* (Kützing and Zopf).

(3) As foreign intruders, more or less commonly occurring in the various specimens examined, were the following:—

α. A pink or rosy yeast-like form—*Cryptococcus glutinis* (Fresenius)?

β. A small white aërobian top-yeast, with peculiar characters, and not identified with any known form.

γ. The ordinary beer-yeast—*Saccharomyces cerevisiæ* (Meyen and Hansen).

δ. Three, or probably four, unknown yeasts of rare occurrence.

ε. A bacillus which forms spores, and liquefies gelatine with a greenish tinge.

ζ. A large spore-forming bacillus, which also liquefies gelatine.

η and θ. Two—perhaps three—other Schizomycetes not identified.

ι. A large yeast-like form which grows into a mycelium, and turns out to be *Oïdium lactis* (Fresenius).

κ. A common blue mould—*Penicillium glaucum* (Link).

λ. A brown "Torula"-like form, which turns out to be *Dematium pullulans* (De Bary).

μ. One, or perhaps several, species of "Torula" of unknown origin and fates.

Saccharomyces pyriformis (n. sp.) is a remarkably anaërobian bottom-yeast, forming spores, and developing large quantities of carbon dioxide, but forming little alcohol. It has also an aërobian form—veil form of Hansen—in which the rounded cells grow out into club-shaped or pyriform cells, whence the proposed specific name. It inverts cane sugar, and ferments the products; but it is unable to ferment milk sugar. It forms rounded, morula-like, white colonies in gelatine, and the author has separated pure cultures from these. He has also studied the development and germination of the spores, which are formed in 24 to 48 hours at suitable temperatures on porous earthenware blocks. They also develop on gelatine.

The specific Schizomycete (*Bacterium vermiforme*, n. sp.) has been very fully studied by the author. It occurs in the fermentations as rodlets or filaments, curved or straight, encased in a remarkably thick, firm, gelatinous sheath, and is pronouncedly anaërobic, so much so, that the best results are got by cultivating it in carbon dioxide under pressure.

The sheathed filaments are so like worms, that the name proposed for the species is appropriately derived from this character.

It will not grow on gelatine, and separation cultures had to be made in saccharine liquids by the dilution methods.

It grows best in solutions of beet-root, or of cane sugar, with relatively large quantities of nitrogenous organic matter—*e.g.* bouillon, asparagin—and tartaric acid. Good results were obtained with mixtures of Pasteur's solution and bouillon.

The author found that the bacterium into which the filaments subsequently break up can escape from its sheath and become free, in which state it divides rapidly, like ordinary bacteria. Eventually, all the forms—filaments, long rods, short rodlets—break up into cocci. No spores have been observed. These changes are dependent especially on the nutritive medium, but are also affected by the gaseous environment and the temperature. The jelly-like clumps of the so-called "ginger-beer plant" are essentially composed of these sheathed and coiled Schizomycetes, entangling the cells of *Saccharomyces pyriformis.* But the fermentative actions of the Schizomycete on the saccharine medium are different when alone, from those exercised when associated with the yeast, or from those exerted by the latter alone.

This was proved by cultivating each separately, and also by cultivations in which, while each organism was submerged in the same fermentable medium, they were separated by permeable porcelain (Chamberland filters), through which neither could pass.

The author has also reconstructed the "ginger-beer plant" by mixing pure cultures of the above two organisms; the Schizomycete entangled the yeast-cells in its gelatinous coils, and the synthesized compound organism behaved as the specimens not analyzed into their constituents. The symbiotic compound organism so closely resembles a lichen, in its morphological aspects, that it may be said to be a ferment-lichen.

Some very curious phenomena in connection with the formation of the gelatinous sheaths and the escape of the bacteria from them were observed in hanging-drop-cultures, and are figured and described by the author. The conditions for the development of the gelatinous sheaths—and therefore of the coherent brain-like masses of the Schizomycete—are a saccharine acid medium and absence of oxygen. The process occurs best in carbon dioxide: it is suppressed in bouillon, and in neutral solutions in hydrogen, though the organism grows in the free, non-sheathed, motile form under these conditions.

The behaviour of pure cultures of the bacteria in as complete a vacuum as could be produced by a good mercury pump, worked daily, and even several times a day, for several weeks, is also noteworthy. The development of the sheaths is apparently indefinitely postponed *in vacuo*, but the organism increased, and each time the pump was set going an appreciable quantity of carbon dioxide was obtained. In vacuum tubes the same gas was evolved, and eventually attained a pressure sufficient to burst some of the tubes. The quantity of carbon dioxide evolved daily by the action of the bacterium alone, however, is small compared with that disengaged when the organism is working in concert with the symbiotic yeast; in the latter case the pressure of the gas became so dangerous that the author had to abandon the use of sealed tubes.

The products of the fermentation due to the Schizomycete have not yet been fully determined in detail; lactic acid, or some allied compound, seems to be the chief result, but there are probably other bodies as well. The author considers that the bacterium removes from the sphere of action substances which, if accumulated, would exhibit the fermentative power of the yeast, hence the advantages of the symbiosis.

The pink yeast-like form proved to be very interesting. It has nothing to do with the "ginger-beer plant" proper, though it was invariably met with as a foreign intruder in the specimens. The author identifies it with a form described by Hansen in 1879 ("Organismer i Öl og Ölurt," Copenhagen, 1879); unfortunately the original is in Danish, but the figures are so good that little doubt is entertained as to the identity. It is also probably the same as Fresenius's *Cryptococcus glutinis* in one of its forms. It is not a Saccharomycete, and does not ferment like a yeast; it is aërobian.

The chief discovery of interest was that in hanging drops the author traced the evolution of this "rose-yeast" into a large complex mycelium, bearing conidia, and so like some of the Basidiomycetes that it may almost certainly be regarded as a degraded or "torula" stage of one of these higher fungi. Full descriptions and figures are given by the author.

The form *Mycoderma cerevisiæ* was thoroughly examined. The author's results confirm what is known as to its aërobian characters. Statements as to its identity with *Oïdium lactis* were not only not confirmed, but the author grew these two forms side by side, and maintains their distinctness. Nor could he obtain spores in this fungus, thus failing to confirm earlier statements to the contrary. He regards it as probable that oil-drops have been mistaken for spores; he also finds that in later stages of fermentation by this organism a strong oily-smelling body is produced.

With regard to *Bacterium aceti*, the author has nothing new to add. A point of some interest was the repeated production of acetic ether, which scented the laboratory, when this Schizomycete was growing in company with the small white aërobian top-yeast referred to under (β). Full details regarding the rest of the organisms, which have nothing to do with the "ginger-beer plant" proper, are given in the original paper.

Physical Society, December 4.—Prof. W. E. Ayrton, F.R.S., President, in the chair.—A paper on a permanent magnetic field was read by Mr. W. Hibbert. The author had noticed the approximate constancy of an "aged" bar magnet, and he obtained still greater constancy by attaching pole pieces to a bar magnet, of such a shape as to give a nearly closed circuit of small "magnetic resistance." The pattern now described consists of a steel rod 1 inch diameter and about $2\frac{1}{2}$ inches long, with a cast-iron disk 4 inches diameter and $\frac{5}{8}$ thick fixed at one end; the other end is fitted in a hemispherical iron shell which surrounds the bar and comes flush with the upper surface of the disk. An annular air space less than $\frac{1}{16}$ inch wide is left between the cylindrical surface of the disk and the inside of the shell, and when the bar is magnetized, a strong magnetic field exists in this space. To use this field for producing electro-magnetic impulses, a coil of wire is wound in a shallow groove on a brass tube which can slide axially through the annular space, thus cutting all the lines. The tube is allowed to fall by its own weight, a neat trigger arrangement being provided for effecting its release. The instrument exhibited had 90 turns of wire in the coil, and the total magnetic flux across the air space was about 30,000 C.G.S. lines. A large electro-magnetic impulse is, therefore, obtainable even through resistances as great as 10,000 ohms. Tests of three instruments show that there has been practically no magnetic decay in seven months. The author therefore considers them satisfactory, and is prepared to supply them as magnetic standards. To facilitate calculation, the number of lines will be adjusted to a convenient number, say 20,000 or 25,000. Several uses to which the instruments are well suited are mentioned in the paper, and a simple way of determining permeability by the magnetometer method is described. Mr. Blakesley thought the name given to the instrument was inappropriate, for it really gave a constant impulsive E.M.F. Dr. Sumpner said the constancy of the sensibility of d'Arsonval galvanometers was a measure of the constancy of magnets having nearly closed circuits. Such instruments, in use at the Central Institution, had remained unchanged for several years. Prof. S. P. Thompson admired Mr. Hibbert's instrument, and thought it would be very useful in laboratories. Standard cells, he said, were not always reliable, and condensers were the most unsatisfactory of electrical standards. On the subject of permanency of magnets, he said that Strouhal and Barus found that magnets with nearly closed circuits were most constant, and that, to give the best results, the hardness of the steel should be less the more closed the circuit. Mr. Hookham had also found that by using a nearly closed circuit, and reducing the strong magnetization by about 10 per cent., great constancy could be obtained. Some years ago he (Dr. Thompson) had tried the effect of ill-treatment on magnets, and observed that touching or hitting a magnet with non-magnetic material had little effect, whilst similar treatment with iron or magnets affected them considerably. Suddenly removing the keeper of a magnet tended to increase the magnetism, whilst putting a keeper on suddenly had the reverse effect. Strouhal and Barus had also investigated the temperature coefficient of magnets, and found that this might be reduced by subjecting the magnet to rapid changes of temperature after the first magnetization, and then remagnetizing. Mr. W. Watson inquired what was the percentage fall in strength of Mr. Hibbert's magnets. The bars used in magnetic surveys had been tested frequently, and they lost about 0·5 per cent. in 6 months. The President asked what were the temperature coefficients of the magnets described in the paper? Mr. Evershed, he said, thought it was between 0·01 per cent. and 0·05 per cent. for ordinary magnets. He thought the instrument shown by Mr. Hibbert would be of immense value if the magnet was really permanent. By it ballistic galvanometers could be readily calibrated, and, when combined with a resistance box, it could also be used as a standard for current; for, since the constant of a ballistic galvanometer for quantity can be determined from its constant for current, if the periodic time be known, conversely that for current can be found from the constant for quantity. In some instances this would be of great use. Speaking of the temperature coefficient of condensers, he said that in some cases the specific inductive capacity of dielectrics diminished with rise of temperature whilst in others it increased. Mr. Hibbert, in reply, said he found the temperature coefficient of his magnets to be, roughly, about 0·03 per cent., but he had not investigated the matter very carefully. In making his measurements no correction had been made for the variation of capacity of his condenser with temperature.—Mr. Walter Baily took the chair, and the President communicated a note on rotatory currents. The subject, he said, was probably familiar to most persons present, for it had been frequently referred to in the scientific papers. Alternate currents could be obtained from an ordinary direct current dynamo by making contact with two points in the armature, say by connecting these points to insulated rings on the shaft, and using extra brushes. A direct current motor similarly treated transforms direct currents into alternating currents, or into mechanical power. If two pairs of points in the armature be selected, situated at opposite ends of two perpendicular diameters, then two alternating currents differing in phase by 90° can be obtained; and by choosing suitable points in the armature, two, three, or more currents differing in phase by any desired angles can be produced. In ordinary motors the connections for doing this would be troublesome, but the Ayrton and Perry form, which has a stationary armature, lends itself readily to this purpose, for contact can be made with any part of the armature with great facility. A motor of this kind was exhibited, in which contact was made with four equidistant points on the armature. On connecting opposite points through fine platinum wires, and running the motor slowly, the wires glowed alternately, one being bright whilst the other was dark, and *vice versâ*, thus demonstrating the existence of two currents in quadrature. When the four points on the armature were joined to the four corners of a square of platinum wire, the wires became incandescent in succession, the glow appearing to travel round the square, and suggesting the idea of rotatory currents. A Tesla alternating current motor was also driven by two currents differing in phase by 90°, obtained from the armature of the Ayrton and Perry direct current motor above mentioned. The ease with which currents differing in phase by any amount can be obtained from such a motor led the author to investigate theoretically the case of two circuits connecting opposite ends of two diameters inclined at any angle, α. Calling the currents in these circuits at any instant, A_1 and A_2, he had found that

$$A_1 = 2nE_0 \frac{\sqrt{\left(r_2+\rho\frac{\pi}{2}\right)^2+\rho^2\left(\frac{\pi}{2}-\alpha\right)^2-2\left(r_2+\rho\frac{\pi}{2}\right)\rho\left(\frac{\pi}{2}-\alpha\right)\cos\alpha}}{\left(r_1+\rho\frac{\pi}{2}\right)\left(r_2+\rho\frac{\pi}{2}\right)-\rho^2\left(\frac{\pi}{2}-\alpha\right)^2}$$

multiplied by $\sin(pt+\phi)$;

where n = number of turns on armature per radian,
ρ = resistance of armature per radian,
r_1 = resistance of external circuit in which current A_1 passes,
r_2 = resistance of external circuit in which current A_2 passes,
E_0 = maximum E.M.F. per convolution
p = angular velocity of rotation, and

$$\tan\phi = \frac{\rho\left(\frac{\pi}{2}-\alpha\right)\sin\alpha}{r_2+\rho\frac{\pi}{2}-\rho\left(\frac{\pi}{2}-\alpha\right)\cos\alpha}.$$

A similar expression, in which r_1 is written for r_2, and r_2 for r_1, gives the value of A_2. The phase angle between the currents is given by

$$\tan(\phi+\psi)=\frac{\left(r_1+\rho\frac{\pi}{2}\right)\left(r_2+\rho\frac{\pi}{2}\right)-\rho^2\left(\frac{\pi}{2}-\alpha\right)^2}{\left(r_1+\rho\frac{\pi}{2}\right)\left(r_2+\rho\frac{\pi}{2}\right)+\rho^2\left(\frac{\pi}{2}-\alpha\right)^2-\frac{\rho\left(\frac{\pi}{2}-\alpha\right)\left(r_1+\rho\frac{\pi}{2}\right)}{\cos\alpha}}\,.\tan\alpha$$

The expression for ϕ shows that the phase of the current in circuit A_1 is independent of the resistance r_1. On the other hand, varying r_2 alters ϕ. It was also pointed out that $\tan(\phi+\psi)$ is generally greater than $\tan\alpha$.—Prof. J. Perry, F.R.S., read a paper on struts and tie-rods laterally loaded. He pointed out that, in the case of struts, a slight want of straightness may considerably reduce the breaking load. Even if a strut be originally straight and the thrust properly distributed, its weight usually produces lateral loading and consequent bending. Similarly, centrifugal force produces lateral loading in connecting rods. For some years the author has given his students practical examples of struts and tie-rods to work out, taking into account the effect of lateral loads. The chief results obtained, together with a general treatment of the whole subject, are embodied in the paper. Where the curves of bending moment and the deflections due to lateral loading can be easily developed by Fourier's series, solutions can readily be found. Simple cases of uniformly loaded struts and tie-bars have been fully worked out, and also the case of locomotive coupling rods. In one problem on the latter subject, a rectangular cross-section was chosen, and the proportions of depth to breadth determined so as to make the rod equally strong in the two directions when running at various given speeds. With cranks 12 inches long, the results show that, at a speed of 390 revolutions per minute, the ratio of depth to breadth must be infinite, so as to give equal strength, so great is the influence of the lateral loading due to centrifugal force, when combined with the thrust. Horizontal tie-rods loaded by their own weight have been investigated, and the tensions required to neutralize compression due to bending determined. A steel bar, 1 inch diameter and 48 inches long, was used as a strut, with a thrust of 1500 pounds. The maximum stress, due to bending by its own weight alone, was 810, and on applying the thrust the maximum stress was raised to 23,190, or about 26 times that due to lateral loading alone. More complex cases have also been treated, the results of which are given in the paper.

PARIS.

Academy of Sciences, December 14.—M. Duchartre in the chair.—On the distribution of prime numbers, by M. H. Poincaré.—On the fixation of nitrogen by arable soils, by MM. Arm. Gautier and R. Drouin. The conclusion is drawn that only soils containing organic matter fix the free or ammoniacal nitrogen of the atmosphere, even in the absence of plants, and that the organic matter existing in all arable soil is an indispensable intermediary in this fixation of nitrogen.—On the camphoric and isocamphoric esters, and the constitution of the camphoric acids, by M. C. Friedel.—Remarks on the history of supersaturation, by M. Lecoq de Boisbaudran. The author gives some notes, made by him in 1866, on the subject of supersaturation, which are in agreement with the phenomena of solution observed in recent years.—Observations of Borrelly's asteroid (Marseilles, November 27, 1891), made at Paris with the East Tower equatorial, by Mdlle. Klumpke. Observations for position were made on November 30, December 2 and 5.—On integrals of the second degree in problems of mechanics, by M. R. Liouville.—On a class of *congruences* of lines, by M. A. Petot.—On the actual state of geodetic and topographic works in Russia, by General Venukoff.—A brief note on the maps of Russia, prepared under the direction of General Kowersky.—On circular polarization, by M. E. Carvallo.—On a thermo-electric standard of electromotive force, by M. Henri Bagard. The author has experimented with thermo-electrolytic couples consisting of two liquids, one an amalgam of zinc, containing a known proportion of this metal, and the other a solution of sulphate of zinc. He finds that such a couple is absolutely constant between two given temperatures, its electromotive force between 0° and $t°$ being given by the formula—

$$E_0 = 0{\cdot}001077t + 0{\cdot}00000090t^2.$$

And it is not necessary to exercise any great precision in the determination of the weight of zinc dissolved in the known weight of mercury to form the amalgam, for the variation of the electromotive force when the couple is at the temperatures 0° and 100° appears to be only 0·0001 volt when the proportion of zinc was varied from 0·00025 to 0·00075 the mass of the mercury.—The three basicities of phosphoric acid, by M. Daniel Berthelot. The basicities have been investigated by the author using a method of determining the electric conductibilities of phosphoric acid solution, and of the same with varying quantities of soda, potash, or ammonia respectively added. The conclusion is drawn that monobasic and bibasic phosphates are stable even in dilute solution, and that the tribasic alkaline phosphates are nearly completely dissociated in dilute solution. Phosphoric acid differs completely from the true tribasic acids as the monobasic and bibasic salts of the latter are partially dissociated by water, and the tribasic salts, on the contrary, are stable in solution.—Salts in solution, sodium sulphate and strontium chloride, by M. A. Etard.—A green solid chromic sulphate, by M. A. Recoura. It has the formula $Cr_2(SO_4)_3,11H_2O$. — Bismuthic acid, by M. G. André.—On the distillation of oil, by M. Pierre Mahler.—A new porcelain, asbestos porcelain, by M. F. Garros.—On the presence of reticulated tissue in the muscular walls of the intestines, by M. de Bruyne.—On the first phases in the development of *Crustacea edriophthalma*, by M. Louis Roule.—On *Gymnorhynchus reptans*, Rud., and its migration, by M. R. Moniez.—On the *rôle* of the foot as a prehensile organ in Hindoos, by M. Felix Regnault. Many travellers have remarked on the ability possessed by most Hindoos of using the foot as well as the hand in work of all descriptions. M. Regnault has made some measurements of the lengths of the feet and toes of a number of natives, and draws some conclusions therefrom as to the adaptation "of the organ to the function."—On the discovery of Tertiary shells in the volcanic tufa of Limburg (Grand Duchy of Baden), by M. Bleicher.—The circulation of winds on the surface of the earth: fundamental principles of the new theory, by M. Duponchel.

CONTENTS. PAGE

Botanical Nomenclature. By W. Botting Hemsley, F.R.S. 169
Applied Thermodynamics. By Prof. A. G. Greenhill, F.R.S. 172
British Flies 173

Our Book Shelf:—

Wright: "Principles of Agriculture" 173
Dyer and Whitcombe: "Elementary Trigonometry" 174

Letters to the Editor:—

Opportunity for a Naturalist.—**Dr. P. L. Sclater, F.R.S.** 174
Warning Colours. (*Illustrated.*)—**Edward B. Poulton, F.R.S.; W. L. Distant** 174
A Difficulty in Weismannism.—**A. H. Trow** . . . 175
Destruction of Immature Sea-Fish.—**Alfred O. Walker** 176
The Salts in Natural Waters.—**F. H. Perry Coste; Robert B. Hayward, F.R.S.** 176
Peculiar Eyes.—**E. B. Titchener** 177
Alleged Pseudopodes of Diatoms.—**Alfred W. Bennett** 177
Intelligence in Birds.—**Joe** 177
A New Locality for Meteoric Iron, with a Preliminary Notice of the Discovery of Diamonds in the Iron. (*Illustrated.*) **By Prof. A. E. Foote** . . 178
The Severe Gale of November 11. (*With Charts.*) By **Chas. Harding** 181
Notes 182

Our Astronomical Column:—

Capture of Comets by Planets 186
Law of Limiting Apertures 186
Connaissance des Temps 186
Orthography of Geographical Names 186
The Eclipse of January 1. (*Illustrated.*) **By W.** . . 188
Simple Proof of Euclid II. 9 and 10. (*With Diagrams.*) By **Miss Hilda Hudson** 189
Scientific Serials 189
Societies and Academies 190